

## STREAMSIDE VERSUS UPSLOPE BREEDING BIRD COMMUNITIES IN THE CENTRAL OREGON COAST RANGE

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**Abstract:** Despite the perceived ecological and management significance of streamside areas in the moist coniferous and mixed deciduous-coniferous forests of the Pacific Northwest, there is little empirical data on the relative importance of streamside habitat to area avifauna. Consequently, we compared breeding bird species diversity, richness, evenness, and individual species' abundance between streamside and upslope areas in 6 mature, unmanaged forest stands in the central Oregon Coast Range, 1988–89. Bird community composition and structure differed between streamside and upslope areas. Species diversity, richness, total bird abundance, and the abundance of 5 species were greater ( $P \leq 0.078$ ) along upslope transects; 2 common species were more abundant ( $P \leq 0.059$ ) along streams. Upslope areas contributed 61% of the total number of birds detected and exclusively contributed 33% of the species; whereas streamside areas exclusively contributed only 9% of the species. Vegetation structure and composition may have been responsible for observed bird distributions. Management of riparian areas alone (e.g., riparian set-asides) may not meet the needs of several bird species. A landscape-level approach that considers both upslope and riparian habitat in conjunction may be more effective in meeting the needs of the entire breeding bird community. Moreover, our results highlight the need to reconceptualize streamside values for terrestrial birds in moist coniferous and mixed coniferous-deciduous forests of western Oregon.

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Riparian areas generally support a greater number of vertebrate species and greater abundance of many species than adjacent uplands (Miller 1951, Thomas et al. 1979, Oakley et al. 1985). In Oregon and Washington, this "riparian influence" is supposedly the result of juxtaposition of water, cover, and food in most riparian areas; a greater diversity of plant composition and structure in riparian areas than adjacent uplands; higher edge-to-area ratios in riparian areas because their elongated shape maximizes edge effects; and more favorable microclimates in riparian areas than surrounding uplands because of increased humidity, higher rates of transpiration, and greater air movement (Oakley et al. 1985:64). These conceptual values of riparian areas have stemmed largely from studies in relatively arid environments where transriparian gradients in microclimate and vegetation are pronounced (Johnson and Jones 1977, Tubbs 1980, Szaro 1980). Under such conditions it is logical that the vegetatively more diverse and productive riparian areas support more species and numbers of wildlife than the relatively simple and less productive uplands. However, it is unclear whether this same conceptual model applies to moist coniferous forests in western Oregon where transriparian gradients are less dramatic.

In addition, much of our understanding of riparian–wildlife relationships is based on ri-

parian areas associated with large streams and rivers where the riparian influence is relatively pronounced. It is unclear whether these relationships extend to smaller mountain streams; yet, small perennial or intermittent mountain streams constitute the majority (83%) of total stream mileage in the Pacific Northwest (Swank 1985) and are the focus of much of the riparian management controversy on commercial forestland there. Further, while the values of these riparian areas to water-dependent wildlife (e.g., fish, beaver [*Castor canadensis*], and American dipper [*Cinclus mexicanus*]) are undeniable, it is unclear whether these areas also provide preferred habitat for terrestrial vertebrates and whether these areas support more numbers and species of vertebrates than adjacent uplands, as is generally assumed.

We investigated the value of second- and third-order streamside areas to breeding birds in mature, unmanaged forest stands in the central Oregon Coast Range. Specifically, we tested the null hypothesis that vegetation composition and structure, bird species diversity, richness and evenness, and the abundance of several species did not differ between streamside and adjacent upslope areas.

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## STUDY AREA

We conducted the study in Drift Creek basin in the central Oregon Coast Range, Lincoln County. Drift Creek is located 20–40 km east of the Pacific Ocean near Waldport, Oregon. Elevation ranges from near sea level to 855 m. Climate is Pacific Northwest Maritime and is characterized by mild, wet winters (Oct–Jun) and cool, dry summers (Jul–Sep). Annual precipitation ranges from 150 to 300 cm and occurs primarily during the winter months in the form of rain with some snow at high elevations; temperatures during January and July average 2.4 and 16.6 C, respectively (Franklin and Dyrness 1973:71–72).

The Drift Creek watershed encompasses approximately 180 km<sup>2</sup> and is characterized by steep slopes and deeply cut drainages. The area is almost entirely forested and lies within the western hemlock (*Tsuga heterophylla*) vegetation zone (Franklin and Dyrness 1973:70–108). The mature forest overstory is dominated by Douglas-fir (*Pseudotsuga menziesii*), western hemlock, and red alder (*Alnus rubra*); western redcedar (*Thuja plicata*) and bigleaf maple (*Acer macrophyllum*) also are common. Understory vegetation is variable in composition and patchy in distribution; common species include salmonberry (*Rubus spectabilis*), vine maple (*Acer circinatum*), salal (*Gaultheria shallon*), stinking currant (*Ribes bracteosum*), Oregon grape (*Berberis* spp.), huckleberry (*Vaccinium* spp.), devil's club (*Oplopanax horridum*), and ferns (primarily *Polystichum munitum*). Franklin and Dyrness (1973:70–108) provide a more complete description of the vegetation.

The entire area burned in the mid-1800's and regenerated naturally. As a result of past timber management, the forest currently possesses a bimodal age distribution, consisting of a matrix

of mature (120–140 years), unmanaged forest stands dominated by Douglas-fir and red alder embedded with numerous small (8–25 ha), young (0–30 years), intensively managed, even-aged, Douglas-fir plantations.

## METHODS

### Sampling Design

We selected 6 second- and third-order streams (Strahler 1952:1120) in large (>60 ha), mature, unmanaged forest stands distributed throughout Drift Creek basin. Stands were selected to represent a range in overstory dominance conditions, ranging from conifer-dominated stands to those with an equal mixture of conifers and hardwoods. Selected sites represented vegetation conditions typical of mature forest stands in the central Oregon Coast Range. Bank-full streams averaged 2.8 m wide (SE = 0.4, range 2.0–5.0) and drained an average of 197 ha (SE = 34, range 82–330) of land. We arbitrarily established 2 transects along each of the 6 streams: (1) a 700-m streamside transect located adjacent ( $\leq 20$  m) and parallel to the stream axis, and (2) a 700-m upslope transect located 400 m upslope and parallel to the stream transect (Fig. 1). We established 8 sample points at 100-m intervals along each transect for a total of 48 streamside and 48 upslope sample points distributed evenly over the 6 stands. All sample points were  $\geq 100$  m from the nearest forest edge created by a road or young ( $\leq 30$  years), managed stand.

### Vegetation Sampling

We sampled vegetation structure and composition in 20-m radius (0.13 ha) circular plots centered on the sample points. Forty-one habitat variables were either directly measured or derived for each plot (Table 1). Vegetation cover was divided into 5 height strata based on the natural layering of the dominant vegetation. Each stratum represented a vertical section of an imaginary column extending from the forest floor to the forest canopy, although the separation of herbaceous and low shrub layers was based on plant species. Herbaceous layer included all herbs except ferns. Ferns were included in the low shrub layer because they were generally 0.3–1.3 m in height and functioned structurally more as shrubs than as herbaceous ground cover. We visually estimated the amount of vegetation cover present in each stratum independently; consequently, individual trees and

Table 1. Habitat characteristics measured in 20-m radius circular plots (0.13 ha) centered on bird count points in 6 mature, unmanaged forest stands in the Drift Creek basin, Lincoln County, Oregon, 1988.

Habitat attribute	Description
Cover (%)	
Herbaceous	0.0–1.3 m, grasses & forbs, OE <sup>a</sup>
Low shrub	0.0–1.3 m, ferns & woody shrubs, OE
Tall shrub	1.3–4.0 m, woody shrubs, OE
Midstory	4.0 m to overstory, woody plants, OE
Overstory	overstory trees, OE
Individual species <sup>b</sup>	0.0 m to overstory, OE
Snags/ha	
Small decay class 6	stumps, 10–19 cm basal diameter, <2 m tall
Medium decay class 1	snags, 20–49 cm dbh <sup>c</sup> , >2 m tall, DC <sup>d</sup> 1
Medium decay class 2–3	snags, 20–49 cm dbh, >2 m tall, DC 2–3
Medium decay class 4–5	snags, 20–49 cm dbh, >2 m tall, DC 4–5
Medium decay class 6	stumps, 20–49 cm basal diameter, <2 m tall
Large decay class 1	snags, >49 cm dbh, >2 m tall, DC 1
Large decay class 2–3	snags, >49 cm dbh, >2 m tall, DC 2–3
Large decay class 4–5	snags, >49 cm dbh, >2 m tall, DC 4–5
Large decay class 6	stumps, >49 cm basal diameter, <2 m tall
Total	total stumps and snags
Basal area (m <sup>2</sup> /ha)	
Conifers	conifer basal area, 20 baf <sup>e</sup> prism
Hardwoods	hardwood basal area, 20 baf prism
Snags	snag basal area, 20 baf prism
Total	total basal area

<sup>a</sup> OE = Ocular estimate.<sup>b</sup> See Table 2 for list of individual species.<sup>c</sup> dbh = Diameter breast height.<sup>d</sup> DC = Decay class (see Cline et al. 1980).<sup>e</sup> baf = Basal area factor.

transect by stand interaction was used as the error term to test the transect effect, unless the mean square error for the interaction term was less than the overall mean square error (i.e.,  $F < 1$ ), in which case the interaction term was left out of the model and transect was tested with the overall error term. This procedure controlled for differences among stands (analogous to a paired  $t$ -test in which transects were paired by stand) and, in effect, caused transects (rather than sample points) to serve as the independent observations. The ANOVA approach produced 96 residuals (associated with the 96 sample points) which enabled us to evaluate properties of the data (i.e., evaluate test assumptions) not possible with the paired  $t$ -test. Although the 96 residuals represented subsamples and were therefore not independent, test assumptions were better examined using the subsamples than limiting the residual analysis to the 12 independent samples (i.e., transects; T. Sabin, Oreg. State Univ., pers. commun.). In cases where residuals were not normally distributed or where they indicated heterogeneous variances, we used appropriate variable transformations (logit, log<sub>10</sub>,

or rank transformations) to improve the distribution of the residuals. In cases where transformations failed to produce acceptable improvements in the residuals, we also used Wilcoxon's sign-rank test to compare variables between transects. In all cases the transformations and nonparametric approaches confirmed the parametric analysis. Therefore, we present only the results from the parametric analysis on the untransformed variables.

To compare bird communities between streamside and upslope transects, it was necessary to account for reduced detectability of birds along streams resulting from excess stream noise. While moving between sample points along high-gradient stream sections (i.e., loud streams) during surveys, we sometimes detected individual singing or calling birds that were not detectable from either point, especially for species with characteristically soft vocalizations (e.g., golden-crowned kinglet [*Regulus satrapa*]), even though effective detection distances (Reynolds et al. 1980) were not different between streamside and upslope transects for most species. Based on these observations, we believed that birds

Table 2. Streamside ( $n = 6$  transects) and upslope ( $n = 6$  transects) habitat characteristics in 6 mature, unmanaged forest stands in the Drift Creek Basin, Lincoln County, Oregon, 1988.

Habitat attribute <sup>a</sup>	Streamside		Upslope		Test statistics <sup>b</sup>	
	$\bar{x}$	SE	$\bar{x}$	SE	F	P
<b>Structure</b>						
Vegetation cover (%)						
Herbaceous	39.8	7.6	14.8	6.8	24.78	0.004
Low shrub	22.3	1.8	72.8	6.7	49.31	0.001
Tall shrub	74.7	2.9	24.9	7.2	48.74	0.001
Midstory	21.9	2.5	12.3	2.7	5.66	0.063
Overstory	43.6	3.7	69.1	1.3	27.39	0.003
Snags/ha						
Small decay class 6	4.6	1.0	16.9	2.5	15.56	0.011
Medium decay class 1	0.2	0.2	3.2	1.8	2.93	0.147
Medium decay class 2-3	1.0	0.3	2.8	1.1	2.06	0.210
Medium decay class 4-5	2.0	1.1	16.8	3.3	24.37	0.004
Medium decay class 6	6.0	1.4	10.1	1.4	6.96	0.046
Large decay class 1	0.5	0.3	0.7	0.5	0.06	0.822
Large decay class 2-3	1.3	0.3	6.1	3.9	1.39	0.292
Large decay class 4-5	7.5	1.7	18.7	2.8	19.17	<0.001
Large decay class 6	3.5	1.1	10.6	2.1	6.05	0.057
Total	26.5	1.9	85.9	7.9	68.32	<0.001
Basal area (m <sup>2</sup> /ha)						
Conifers	17.5	2.7	54.3	7.5	17.24	0.009
Hardwoods	8.1	2.1	8.2	3.3	0.00	0.976
Snags	6.0	1.2	18.8	3.3	13.41	0.015
Total	31.7	2.9	81.3	7.8	27.20	0.003
<b>Floristics (% cover)</b>						
Herbs						
Forbs	35.6	6.0	10.4	3.6	34.85	0.002
Ferns	9.7	1.6	52.3	6.7	32.86	0.002
Grasses	4.2	0.8	4.4	0.8	0.08	0.788
Shrubs <sup>c</sup>						
Salmonberry	56.4	4.6	9.6	7.8	26.39	0.004
Vine maple	17.9	4.2	7.1	3.4	8.06	0.036
Stinking currant	14.4	6.1	0.1	0.0	5.51	0.066
Devil's club	4.0	1.1	0.4	0.4	11.43	0.001
Huckleberry	2.1	0.4	5.6	1.2	12.84	0.016
Oregon grape	0.0	0.0	8.3	2.8	8.47	0.033
Salal	0.0	0.0	17.0	6.2	7.51	0.041
Trees						
Red alder	40.4	6.7	22.6	8.6	4.13	0.098
Bigleaf maple	3.7	2.6	0.1	0.1	1.96	0.220
Douglas-fir	14.4	4.1	59.5	6.1	24.21	0.004
Western hemlock	10.5	3.5	10.5	4.9	0.00	1.000
Western redcedar	7.1	2.8	0.5	0.3	6.61	0.050
Hardwoods total	44.1	8.1	22.7	8.6	4.60	0.085
Conifers total	31.9	5.1	67.7	7.8	19.10	0.007

<sup>a</sup> Described in Table 1.<sup>b</sup> 2-way ANOVA with site as block and site by transect interaction used as error term to test transect effect, when appropriate (i.e., transect = experimental unit and 1,5 df for all variables except large decay class 4-5 snags and devil's club, in which case 1,89 df).<sup>c</sup> Other shrubs found on streamside plots ( $\leq 1.6\%$  cover) included California hazel (*Corylus cornuta*), Pacific elder (*Sambucus* spp.), Indian peach (*Oemleria cerasiformis*), and oceanspray (*Holodiscus discolor*). Other shrubs found on upslope plots ( $\leq 0.6\%$  cover) included oceanspray and rhododendron (*Rhododendron macrophyllum*). None differed ( $P > 0.102$ ) between streamside and upslope transects.

conifer basal area and fewer snags of several size and decay classes, particularly the later stages of decay (decay classes 4-6), than upslopes (Table 2).

Floristic composition differed noticeably between streamside and upslope areas. Differences in growth-form among plant species largely accounted for differences in vegetation

Table 3. Individual and interactive effects of transect (streamside vs. upslope), year (1988 vs. 1989), and site (6 mature, unmanaged forest stands) on breeding bird species abundance, diversity, richness, and evenness in the Drift Creek basin, Lincoln County, Oregon, 1988–89.<sup>a</sup>

Species <sup>b</sup>	Stream		Upslope		Effect <sup>c</sup>	Test statistics <sup>c</sup>		
	$\bar{x}^d$	SE	$\bar{x}$	SE		F	df	P
Brown creeper	3.5	1.0	13.2	2.2	T	8.35	1,5	0.034
					T*S	2.39	5,10	0.113
					T*Y	0.68	1,10	0.427
Chestnut-backed chickadee	6.1	1.0	14.4	1.9	T	6.23	1,5	0.055
					T*S	2.38	5,10	0.114
					T*Y	0.00	1,10	0.991
Dark-eyed junco	0.7	0.4	2.5	0.8	T	4.89	1,5	0.078
					T*S	1.93	5,10	0.177
					T*Y	1.59	1,10	0.236
Golden-crowned kinglet	2.7	0.6	16.7	3.0	T	35.13	1,15	<0.001
					T*S	0.57	5,10	0.720
					T*Y	0.01	1,15	0.925
Hammond's flycatcher	0.0	0.0	9.8	1.6	T	553.12	1,15	<0.001
					T*S	0.69	5,10	0.644
					T*Y	24.78	1,15	<0.001
Steller's jay	1.5	0.4	1.4	0.4	T	0.07	1,5	0.804
					T*S	2.09	5,10	0.151
					T*Y	0.33	1,10	0.577
Swainson's thrush	9.6	1.6	7.3	3.1	T	5.93	1,5	0.059
					T*S	2.15	5,10	0.142
					T*Y	0.03	1,10	0.858
Western flycatcher	6.5	1.4	4.3	0.9	T	0.87	1,5	0.394
					T*S	1.07	5,10	0.431
					T*Y	0.05	1,10	0.821
Wilson's warbler	8.3	1.5	8.2	2.0	T	0.27	1,5	0.623
					T*S	8.00	5,10	0.003
					T*Y	2.23	1,10	0.166
Winter wren	17.8	1.4	12.1	1.1	T	12.22	1,5	0.017
					T*S	1.68	5,10	0.226
					T*Y	0.63	1,10	0.446
Total abundance (all species)	61.3	4.3	97.8	6.0	T	38.20	1,15	<0.001
					T*S	0.83	5,10	0.559
					T*Y	0.15	1,15	0.702
Diversity	0.836	0.024	0.932	0.023	T	12.57	1,15	0.003
					T*S	0.81	5,10	0.569
					T*Y	1.25	1,15	0.281
Richness	10.1	0.6	13.3	0.7	T	15.63	1,15	0.001
					T*S	0.81	5,10	0.569
					T*Y	1.04	1,15	0.323
Evenness	0.840	0.011	0.837	0.014	T	0.03	1,15	0.858
					T*S	0.34	5,10	0.876
					T*Y	0.01	1,15	0.906

<sup>a</sup> Data represent birds detected  $\leq 40$  m from count points along transects and  $\leq 20$  m from count points perpendicular to transects, and includes only species with  $\geq 30$  total observations.

<sup>b</sup> Scientific names in Appendix or text.

<sup>c</sup> 3-way ANOVA (model: Abundance = Site + Transect + Year + Transect\*Site + Transect\*Year) with Site as block and Site by Transect interaction used as the error term to test Transect effect, when appropriate (i.e., transect = experimental unit).

<sup>d</sup> Mean number detected during 6 visits/transect/year ( $n = 12$ ).

<sup>e</sup> T = transect effect; T\*S = transect by stand interaction; T\*Y = transect by year interaction.

ondary cavity nesters and depend primarily on snags to provide nest substrates (Mannan et al. 1980, Mariani 1987:28, Nelson 1988:73), and densities of both species have been positively associated with densities of large conifers (Stur-

man 1968, Mannan et al. 1980, Manuwal and Huff 1987, Morrison et al. 1987, Lundquist 1988: 33–38); brown creepers also have been reported to avoid hardwoods (Mariani 1987:34), which were more abundant along streams in our study.

stands or about potential bird associations in narrow streamside buffer strips of mature forest.

Third, our study was limited to second- and third-order streams. Results from other studies suggest that streamside versus upslope associations may vary significantly along the intrariparian gradient. Knopf (1985) noted a change in streamside-upslope associations along an elevational gradient in the Colorado Front Range, and Stauffer and Best (1980) noted a strong positive correlation between bird species richness and the width of riparian habitat in Iowa. Based on results of these and other studies, it is conceivable that species richness and the number of unique species found along streamside may be greater than upslope forests further downstream where edaphic, hydrologic, and geomorphic conditions interact with geomorphic disturbance processes to create a larger and more distinct (i.e., unique) riparian vegetation community.

Fourth, our sampling was limited to diurnal birds during the breeding season. Nocturnal birds were not included in our quantification of bird communities and, more importantly, we did not assess seasonal changes in streamside-upslope bird associations. Bird community organization is known to fluctuate seasonally in a variety of habitat types, including riparian areas (Fretwell 1972, Rice et al. 1980, Szaro 1980).

Finally, our sampling was designed to estimate relative abundance of birds in plant communities adjacent to streams (i.e., streamside) and upslope areas based largely on aural detections of singing and calling birds (96% of detections were aural). We did not attempt to assess bird use of the stream itself either by water-associated species (e.g., American dipper, mallards [*Anas platyrhynchos*], etc.) or by terrestrial species. Consequently, upslope birds may have gone undetected if they periodically used streams without vocalizing, or drank and bathed during afternoons or evenings.

## MANAGEMENT IMPLICATIONS

The strength and durability of the current riparian-wildlife conceptual model is based on its general applicability and its strong communicative power. However, the very strength of this conceptual model has inhibited researchers and land managers from questioning its applicability in specific environmental settings and has led land managers and others to believe that riparian areas universally support more species

and numbers of vertebrates than uplands. As a result, those land managers interested in biodiversity often have focused wildlife management efforts on riparian areas with less regard for uplands. In western Oregon, for example, riparian management strategies have been developed for the protection of multiple forest resources, including water, fish, and wildlife, and management efforts often have given disproportionate attention to riparian areas because of these multiple resource values. However, these efforts have proceeded with little or no quantitative understanding of how riparian areas contribute to the needs of terrestrial vertebrates across the landscape.

It has been widely assumed that streamside areas provide habitat for more terrestrial vertebrates than other habitats. Our results suggest that this assumption may not be true for diurnal birds along second- and third-order streams in mature forests, and riparian management alone may not meet the needs of the breeding avifauna of mature forest stands of the central Oregon Coast Range; a landscape-level approach that considers upslope habitat and riparian habitat in conjunction may be more effective.

Recently, it has been suggested that streamside areas function as natural migration routes and travel corridors for the movement and dispersal of animals among suitable habitat patches (Wauer 1977, Oakley et al. 1985:64). Harris (1984:141-144) and Franklin et al. (1981:41) suggested that riparian areas could be used to link mature forest habitat patches in a landscape, and Knopf et al. (1988) suggested that streamside corridors facilitate faunal mixing throughout a watershed or landscape. For species strongly associated with mature forests and upslope areas, however, riparian areas may not provide suitable travel and dispersal routes, and as a result may not constitute an effective management strategy for these species. Two of the 5 bird species associated with mature forest and upslope areas in our study (chestnut-backed chickadee and golden-crowned kinglet) have experienced significant annual population declines in western Oregon and Washington over the past 20 years (Sam Droege, U.S. Fish & Wildl. Serv., Laurel, Md., pers. commun.). Thus, land managers may wish to consider expanding riparian corridor width to include optimal habitat for these and other species associated with mature forests and upslope areas, although further research is necessary to determine the ap-

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## APPENDIX. Continued.

Species (scientific name)	$N_t^a$	$N_r^b$	Stream		Upslope	
			$\bar{x}^c$	SE	$\bar{x}$	SE
Townsend's warbler ( <i>Dendroica townsendi</i> )	1					
Vaux's swift ( <i>Chaetura vauxi</i> )	9					
Wrentit ( <i>Chamaea fasciata</i> )	9					

<sup>a</sup>  $N_t$  = Total number of detections at all distances.

<sup>b</sup>  $N_r$  = Total number of detections within 40 m of count points along transects and within 20 m of count points perpendicular to transects (i.e., restricted sampling area).

<sup>c</sup> Mean number of detections during 6 visits/transect/year ( $n = 12$ ) within restricted sampling area.

<sup>d</sup> Detected on a single occasion.